

GAO

Report to the Subcommittee on Air and  
Land Forces, Committee on Armed  
Services, House of Representatives

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August 2008

# DEFENSE ACQUISITIONS

## Department of Defense Needs Framework for Balancing Investments in Tactical Radios



G A O

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Highlights of [GAO-08-877](#), a report to the Subcommittee on Air and Land Forces, Committee on Armed Services, House of Representatives

## Why GAO Did This Study

The Department of Defense (DOD) has spent an estimated \$12 billion on the development and production of tactical radios over the last 5 years—about as much as was spent producing Virginia Class submarines (\$10.8 billion) in the same period. Survivability and lethality in warfare are increasingly dependent on superior information and communication capabilities. DOD is counting on the Joint Tactical Radio System (JTRS) to deliver the breakthroughs in this area. At the same time as it is developing JTRS, DOD wants to ensure that current forces are equipped with sufficient legacy radios. To address Subcommittee concerns regarding DOD's approach to meeting current and future radio needs, GAO examined this subject. In response, this report addresses (1) how planned investments in key tactical radio systems changed over the last 5 years, (2) why these changes occurred, and (3) the challenges ahead.

To assess these topics, GAO's work included reviewing 2003 through 2007 budget requests, legacy radio procurements, and the status of the JTRS program; and interviewing officials from DOD organizations.

## What GAO Recommends

GAO recommends that the Secretary of Defense develop a comprehensive investment strategy for tactical radios and take actions to improve oversight of their acquisition. In commenting on a draft of this report DOD agreed with these recommendations.

To view the full product, including the scope and methodology, click on [GAO-08-877](#). For more information, contact Paul Francis at (202) 512-4841 or [francisp@gao.gov](mailto:francisp@gao.gov).

# DEFENSE ACQUISITIONS

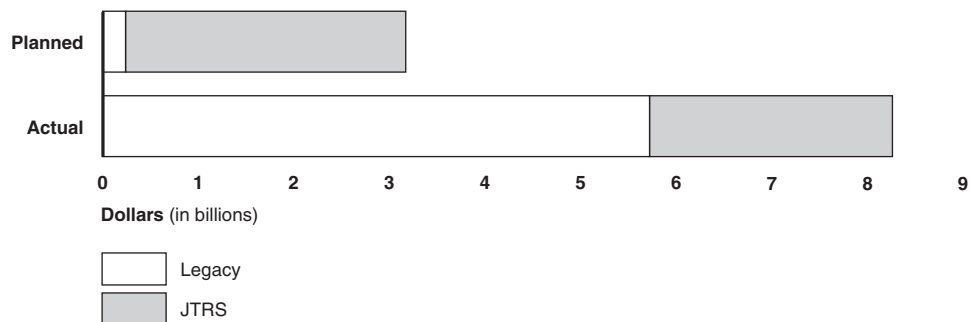
## Department of Defense Needs Framework for Balancing Investments in Tactical Radios

### What GAO Found

Over the past 5 years, DOD investments in key tactical radios have shifted dramatically, both in size and composition. In 2002, when JTRS first began system development, DOD planned to invest close to \$3 billion in JTRS over fiscal years 2003-2007. However, as shown below, actual investments more than doubled and shifted to producing thousands more legacy radios. Compared with the \$3.2 billion that was slated to be spent on JTRS and the Army and Marine Corps legacy radios, about \$8.3 billion was actually spent. Of this, about \$5.7 billion was spent on the legacy radios, while \$2.5 billion was spent on JTRS development.

### Planned and Actual Spending on Tactical Radios, 2003-07

Development and Procurement of Tactical Radios, fiscal years 2003 and 2007



Source: GAO analysis of service and JTRS annual budget requests.

The change in tactical radio investments was brought about by (1) delays in the development and production of JTRS and (2) urgent demands for more radios to equip current forces. JTRS has encountered significant cost, schedule, and performance problems, causing some users to buy more legacy radios instead. Moreover, the military services' demand for tactical radios soared because of combat operations, the need to equip Guard and Reserve forces with modern radios, and to add more radios per combat unit. Supplemental funding of \$5.5 billion paid for most of these legacy radios.

Over the next 5 years, DOD faces several challenges in providing needed tactical communications capabilities to the warfighter, including:

- Overcoming technology hurdles, size and power constraints, and security architecture issues to complete JTRS development.
- Managing investments within defined fiscal constraints. A legacy vehicle radio costs about \$20,000, while its more capable JTRS replacement is estimated to cost up to 10 times more.
- Phasing in JTRS without prematurely retiring a relatively young inventory of legacy radios.

DOD does not have a strategy to meet these challenges and thus runs the risk of having its future communications capabilities decided ad hoc.

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# Contents

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<b>Letter</b>		<b>1</b>
	Results in Brief	2
	Background	4
	Investment in Key Tactical Radio Systems Has Shifted Dramatically in Both Size and Composition	8
	Dramatic Change in Tactical Radio Investments Is Due Primarily to Delays with JTRS and Near-Term Operational Needs	9
	Strategy for Acquiring Tactical Radios over Next Several Years in Flux	17
	Conclusions	27
	Recommendations for Executive Action	27
	Agency Comments and Our Evaluation	28
<b>Appendix I</b>	<b>Scope and Methodology</b>	<b>30</b>
<b>Appendix II</b>	<b>Characteristics of Selected Tactical Radios</b>	<b>32</b>
<b>Appendix III</b>	<b>Comments from the Department of Defense</b>	<b>35</b>
<b>Appendix IV</b>	<b>GAO Contact and Staff Acknowledgments</b>	<b>37</b>
<b>Tables</b>		
	Table 1: Comparison of Frequency Band, Nominal Channel Bandwidth, and Data Rates for Selected Legacy Waveforms and New Wideband Waveforms	6
	Table 2: JTRS Procurement Quantities	22

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## Figures

Figure 1: Comparison of Planned and Actual Spending for Tactical Radios	8
Figure 2: Impact of Restructuring on JTRS Schedules	10
Figure 3: Army's Total Authorized Acquisition Objective for SINCGARS	15
Figure 4: Funding for Army and Marine Corps Tactical Radios	16

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United States Government Accountability Office  
Washington, DC 20548

August 15, 2008

The Honorable Neil Abercrombie  
Chairman  
The Honorable Jim Saxton  
Ranking Member  
Subcommittee on Air and Land Forces  
Committee on Armed Services  
House of Representatives

The Department of Defense (DOD) has spent an estimated \$12 billion on the development and production of tactical radios over the last 5 years. To put this investment in context, the amount spent on tactical radios is comparable to the estimated investments made in the Army's Future Combat Systems (\$10.4 billion) and the Navy's production of Virginia Class submarines (\$10.8 billion) during the same period.

Survivability and lethality in warfare are increasingly dependent on smaller, highly mobile, joint forces that rely on superior information and communication capabilities. Moving this information—including bandwidth-intensive data and video—to, from, and across the battlefield requires breakthroughs in radio technology. DOD's existing or "legacy" radios lack the capacity and flexibility necessary to achieve and maintain this level of information superiority. DOD is counting on the Joint Tactical Radio System (JTRS), a development program begun in 1997, to deliver the needed breakthrough. JTRS relies on networked communications to improve information sharing, collaboration, and situational awareness, thus enabling more rapid and effective decision making and execution on the battlefield. It is intended to provide the bandwidth volume to handle the information traffic, emulate different legacy radios, and function as a router for tactical networks. The design of some new weapon systems, such as the Future Combat Systems, depends on a JTRS-equipped network.

At the same time DOD is developing JTRS for future forces, it is striving to ensure that current forces are equipped with legacy radios to carry out assigned missions. DOD is confronted with the challenge of balancing the investment in both current and future radios—a dynamic proposition given that current needs change and future capabilities do not necessarily proceed predictably. To determine whether DOD and the military services are acquiring radios in the most cost-efficient and effective manner and

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have developed a strategy to balance near- and long-term requirements, address capability gaps, and determine funding needs, the Subcommittee requested that GAO study how effectively DOD and the military services are managing the acquisition of radio systems. Specifically, we (1) examined how the services' planned investments in key tactical radio systems have changed over the last 5 years, (2) determined why these changes occurred, and (3) identified challenges that will confront the services as they plan tactical radio investments to provide desired future capabilities.

We conducted this performance audit from July 2007 to July 2008 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

To assess tactical radio investments and risks, we reviewed fiscal year 2003 through 2007 budget<sup>1</sup> requests, procurements of legacy radios for that time period, the current status of the JTRS program, and JTRS migration plans. We interviewed agency officials from various DOD and service organizations and reviewed plans and reports produced by Defense organizations. More details about our scope and methodology are in appendix I.

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## Results in Brief

Over the past 5 years, DOD investments in key tactical radios have shifted dramatically, both in size and composition. In 2002, when the JTRS program began system development, DOD planned to invest close to \$3 billion in JTRS over fiscal years 2003-2007—about \$1 billion to develop and test the radios and another \$2 billion to start procuring them. Investment in legacy radios was expected to be relatively small and diminish almost entirely as JTRS became available. For example, the Army and Marine Corps planned to spend only about \$235 million between 2003 and 2007 on legacy radios for ground vehicles and soldiers/marines. However, actual investments more than doubled and shifted away from planning to produce JTRS to producing thousands more legacy radios.

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<sup>1</sup> We were only able to identify tactical radio investments in Army and Marine Corps budget documents; we were unable to identify tactical radio investments for the Air Force and Navy as these services do not centrally procure radios.

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Compared with the \$3.2 billion that was slated to be spent on JTRS and the Army and Marine Corps legacy radios, about \$8.3 billion was actually spent. Of this, about \$5.7 billion was spent on the legacy radios, while \$2.5 billion was spent on JTRS development. Other than fielding an enhanced legacy handheld radio, no JTRS networking radios were produced or fielded during this time.

The change in tactical radio investments was brought about by two primary factors: (1) delays in the development and production of JTRS and (2) urgent demands for additional radios to equip current forces. JTRS encountered significant cost, schedule, and performance problems early in its development. The program was restructured in 2006, resulting in the deferral of some capabilities and the addition of much more time and funding to complete development. While prudent, the restructuring delayed the fielding of the first JTRS Ground Mobile Radios by 5 years to 2010. Because of the delay, some users who were depending on JTRS such as Army helicopter programs had to buy more legacy radios instead. At the same time, however, the military services' demand for tactical radios soared—a demand that was met by buying tens of thousands of legacy radios. The demand was fueled by combat operations in Iraq and Afghanistan, the need to equip Guard and Reserve forces with modern radios, and a change in the Army and Marine Corps' concept of operations that calls for more radios per combat unit. The resultant investments in legacy radios have evolved from year to year, as the services reacted to needs that cropped up, and were largely enabled by supplemental funding, which supplied most—an estimated \$5.5 billion—of the additional funds. Because DOD developed the supplemental budgets relatively quickly and without the level of review and oversight normally required through the regular annual budget process, there was limited visibility into the services' plans for acquiring tactical radios. In addition, a waiver/notification process established by the Office of the Secretary of Defense to help manage the transition from legacy radios to JTRS has not been effective in tracking the nature and extent of tactical radio investments.

Over the next 5 years, DOD faces several challenges in providing needed tactical communications capabilities to the warfighter: completing JTRS development, managing investments within tighter fiscal constraints, and developing a fielding strategy for tactical radios. While JTRS is making progress, the program must still overcome technology hurdles, size and power constraints, and security architecture issues to avoid further delays. The high cost of JTRS has also become an increasing concern. Currently, a legacy vehicle radio costs about \$20,000, while its JTRS replacement,



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albeit significantly more capable, is estimated to cost up to 10 times more. In addition, the cost of integrating JTRS with existing weapons systems is expected to be substantial in some cases. Thus, the decision to put more radios in each combat unit may not be sustainable with the more costly JTRS. In fact, the military services have begun to scale back the number of JTRS radios they plan to buy and rethink how JTRS capabilities will be fielded. Since the recently purchased legacy radios are expected to have a useful life of 10-15 years, fielding JTRS without phasing out legacy radios prematurely will necessitate striking a balance between capability and cost. For example, DOD may have to consider whether the investment priority for JTRS should be on network-dependent systems, like the Army's Future Combat Systems, or for replacing legacy radios. Available funding, absent continued high levels of supplemental budgets, will likely not support meeting both sets of needs. However, DOD does not have a strategy for balancing its future tactical radio investments, as previous plans are outdated.

We are recommending that the Secretary of Defense develop an investment strategy that establishes priorities to guide resource decisions on legacy radios, upgraded radios, and the new generation of radios that JTRS represents. We are also recommending that such a strategy provide discipline to bound investment decisions, such as a reinvigorated notification/waiver process, as well as a back-up plan in the event that JTRS does not provide the desired capabilities on time. In commenting on a draft of this report, DOD agreed with these recommendations.

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## Background

Survivability and lethality in warfare are increasingly dependent on smaller, highly mobile, joint forces that rely on superior information and communication capabilities. DOD's existing tactical radio systems lack the functionality and flexibility necessary to achieve and maintain information superiority or to support the rapid mobility and interoperability desired by the armed forces. Most of these radios were designed with mutually exclusive architectures to perform specific tasks and can only interoperate with like radios. Their functions are largely governed by their hardware components. In addition, they operate at low to medium data rates, have limited networking capabilities, and are not capable of simultaneous voice, data, and video operations. Furthermore, the radios have many unique components and parts that require specialized support and create a logistics burden.

The military services use many different types of tactical radios, including some that were developed decades ago. The Single Channel Ground and

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Airborne Radio System (SINCGARS) is the primary means of command and control for Army combat and support units. Different variants of the radio are used in vehicles, aircraft, and as “manpack” radios carried by soldiers. The radios provide voice and limited data capabilities. The Marine Corps also uses SINCGARS, but also relies on the AN/VRC-110 and the AN/VRC-111 radios for its vehicles. These radios have multiple waveforms,<sup>2</sup> including the SINCGARS waveform, and can be pulled out of vehicles and used as handheld radios. The Navy and Air Force use a variety of radios for their airborne platforms; one of the most common is the AN/ARC-210, a single-channel radio which provides voice and data communications over a variety of waveforms. To meet its fixed station and maritime needs, the Navy uses the Digital Modular Radio, which operates on multiple waveforms and provides voice and data capabilities, and other radios. Appendix II provides a more complete list of selected tactical radios currently in use and their capabilities.

To support new operational and mission requirements, DOD determined that the large number and diversity of legacy radios in use would require wholesale replacement or expensive modifications. The JTRS program was initiated in 1997 to exploit advancements in software-defined radio technology and provide superior communications and networking capabilities to the warfighter. Software-defined radios such as JTRS use software rather than hardware to control how the radio works and, as a result, offer significant flexibility to meet a wide variety of needs. Rather than developing radios that are built to different standards and operate on different frequencies as was the case in the past, DOD will develop JTRS as a single, interoperable family of radios based on a common set of standards and applications. The radios are expected to not only satisfy the requirements common to the military’s three operational domains—air, sea, and ground— but be able to communicate directly with many of DOD’s existing tactical radios.

In addition to supporting interoperability, JTRS is intended to contribute to DOD’s goal of network-centric warfare operations by introducing new

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<sup>2</sup> In general usage, a waveform is the representation of a signal and the characteristics of a radio that includes the frequency, (VHF, HF, and UHF), modulation type (FM, AM), message format, and/or transmission system. Most of the radios used by the military services operate with a single waveform and can only interoperate with similar radios. However, several military radios have been developed in recent years that operate multiple waveforms. Thus, for example, if three waveforms are built into a radio, that single radio can emulate three different radios and be compatible with other radios that have these waveforms.

wideband networking waveforms that dramatically increase the amount of data and speed at which the data can be transmitted. The wideband networking waveform being developed for ground vehicles, for example, is expected to provide data rates of up to 5 megabits per second or more which is at least ten times faster than legacy radio systems—akin to upgrading from a “dial-up” modem to a broadband connection. As such, the waveforms would facilitate the use of maps, imagery, and video to support the decision making of tactical commanders at all echelons. Table 1 compares the frequency band, nominal channel bandwidth, and data rates of selected legacy waveforms and new wideband waveforms.

**Table 1: Comparison of Frequency Band, Nominal Channel Bandwidth, and Data Rates for Selected Legacy Waveforms and New Wideband Waveforms**

Waveform	Frequency band (millions of Hertz (MHz))	Nominal channel bandwidth (thousands of Hertz (KHz))	Data rate (thousands of bits per second (Kbps))
Single Channel Ground and Airborne Radio System (SINCGARS)	30 - 88	25	Voice: 16 Data: .075 - 16
Enhanced Position Location Reporting System (EPLRS)	420 - 450	3,000	Data: Up to 1,000
High Frequency	2 - 30	3/6/12	Voice and Data: 11 distinct data rates between .075 – 9.6
Have Quick	225 - 400	25	Voice: 16 Data: .075 - 16
Tactical Data Information Link-Joint (TADIL-J)	960 - 1,215	3,000	Voice: 2.4 and 16 Data: 28.8 – 1,137
Ultra High Frequency Satellite Communications Demand Assigned Multiple Access (UHF SATCOM DAMA)	225 – 400	5 and 25	Voice and Data: .075 – 56, or 64
<b>New</b>			
Wideband Networking <sup>a</sup>	2 - 2,000	25 – 30,000	Data: up to 5,000
Soldier Radio <sup>a</sup>	2 - 2,000	13,000	Data: up to 1,000
Joint Airborne Network – Tactical Edge	2 - 2,000	To be determined	To be determined

Source: GAO analysis of April 2003 JTRS Operational Requirements Document, Annex E.

<sup>a</sup>The Wideband Networking Waveform and Soldier Radio Waveform are actually families of waveforms. The Wideband Networking Waveform family consists of four different waveforms and the Soldier Radio Waveform family consists of three different waveforms.

In addition to providing new wideband waveforms, individual JTRS radios would have the capability to support multiple services (e.g., voice, data,

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and video) and operate on multiple channels simultaneously. For example, a four-channel JTRS radio set intended for a ground vehicle could be programmed to have channels dedicated to SINCGARS, EPLRS, the Wideband Networking Waveform, and the Soldier Radio Waveform. All four channels could be operating simultaneously. Data could also be transferred from one channel (or network) to another through a “gateway” device implemented with hardware and software. Furthermore, since JTRS is expected to operate as a mobile network, each multi-channel JTRS set will function as a router, meaning that it is responsible for passing along information (voice, data, and video) from other JTRS radios.

To manage JTRS’ development, DOD established a joint program office, and service-led product offices clustered by requirements. In 2006, all the JTRS programs were realigned under the authority of a single JTRS Joint Program Executive Officer (JPEO). The JPEO established an organizational structure for JTRS that includes three domains: (1) ground radios; (2) air, maritime, and fixed station radios; and (3) network enterprise services and a program for special radios.

In an effort to manage the transition of tactical radios to JTRS, in 1998, the Office of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence issued a memorandum directing all Component efforts to develop and acquire any radio system be held in abeyance. Service, command, or agency acquisition executives could submit requests for exceptions through the JTRS Joint Program Office and the Assistant Secretary of Defense for Networks and Information Integration.<sup>3</sup> The request for exceptions (or waiver policy) was amended in May 2005. The amended policy suspended the waiver process and only required that notifications of plans to acquire radios be provided to the Assistant Secretary of Defense for Networks and Information Integration.

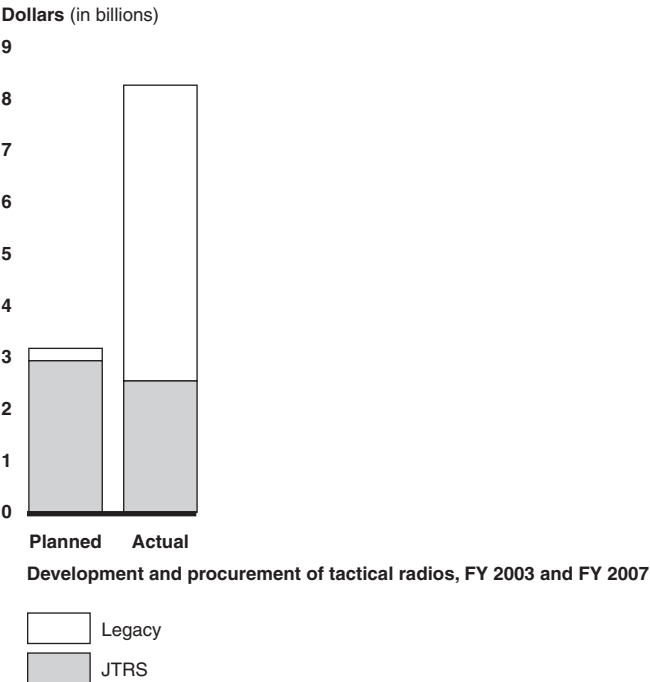
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<sup>3</sup> The Assistant Secretary of Defense for Networks and Information Integration is the successor organization to the Assistant Secretary of Defense for Command, Control, Communications and Intelligence.

# Investment in Key Tactical Radio Systems Has Shifted Dramatically in Both Size and Composition

Over the past 5 years, investments in key tactical radios systems have exceeded planned investments by more than double and shifted dramatically in scope. In 2003, DOD and the services planned to invest mainly in the development and production of JTRS. At the same time, investment in legacy radios was expected to be relatively small and diminish almost entirely as JTRS became available. However, actual spending on tactical radios turned out to be very different. Not only did spending between fiscal years 2003 and 2007 increase significantly, from about \$3.2 billion to about \$8.3 billion, it shifted away from procuring JTRS to procuring tens of thousands of additional legacy radios. See figure 1.

Figure 1: Comparison of Planned and Actual Spending for Tactical Radios



Source: GAO analysis of service and JTRS annual budget requests.

In 2003, DOD and the services planned to spend approximately \$3 billion on JTRS over the next 5 years—\$1 billion for research and development, and \$2 billion to procure the first JTRS radios. The Army and Marine Corps planned to spend approximately \$235 million for legacy radios between 2003 and 2007. The Army planned to spend approximately \$140 million to procure SINCGARS and handheld and “manpack” radios; the

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Marine Corps planned to spend about \$98 million to procure a variety of tactical communications systems.

In actuality, DOD and the services invested over twice as much as planned to develop JTRS capabilities—about \$2.5 billion—while no JTRS networking radios were produced during this time. Legacy radio spending, on the other hand, ballooned to approximately \$5.7 billion, about 24 times what was planned. Of this, the Army spent approximately \$4.1 billion, including \$2.3 billion on SINCGARS radios and \$1.8 billion on handheld and manpack radios. The Marine Corps spent \$1.6 billion on a variety of tactical communication systems.

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## Dramatic Change in Tactical Radio Investments Is Due Primarily to Delays with JTRS and Near-Term Operational Needs

The dramatic change in the size and scope of tactical radio investments over the last 5 years is due to two primary factors. First, cost, schedule, and performance problems delayed development of JTRS capabilities by several years. Second, combat operations in Afghanistan and Iraq have significantly increased the demand for tactical radios—a demand that could only be met by buying legacy radios. The demand was driven by a desire to equip deploying units with modern radios and a change in concept of operations that calls for more radios per unit. The resultant investment in legacy radios evolved from year to year as needs arose and was largely enabled by the availability of supplemental funding. Although a notification process was established to help manage the transition from legacy radios to JTRS, it was not effective in tracking the extent of investments in legacy radios that occurred.

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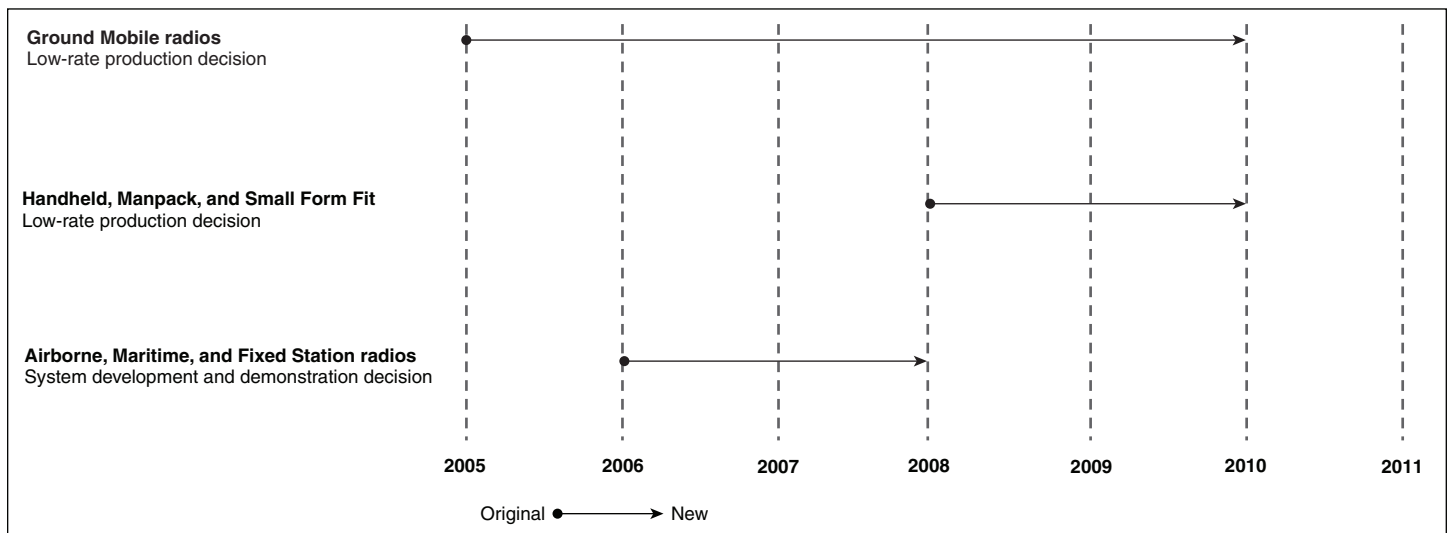
## Development and Production of JTRS Delayed by Several Years

As we have previously reported, developing JTRS has proven to be a significant technical and management challenge.<sup>4</sup> A few years into system development, the program experienced considerable cost and schedule overruns and performance shortfalls, necessitating a major restructuring of the program in 2006. As a result, considerably more time and funding were added to complete the first increment of JTRS. The revised schedules for each of the JTRS program components expanded development times by several years (see Fig. 2).

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<sup>4</sup> GAO, *Challenges and Risks Associated with the Joint Tactical Radio System Program*, [GAO-03-879R](#) (Washington, D.C.: Aug. 11, 2003); GAO, *Defense Acquisitions: Restructured JTRS Program Reduces Risk, but Significant Challenges Remain*, [GAO-06-955](#) (Washington, D.C.: Sept. 11, 2006).

**Figure 2: Impact of Restructuring on JTRS Schedules**



Source: GAO analysis of JTRS JPEO data.

<sup>a</sup>The pre- and post restructuring components of the Handheld, Manpack, and Small Form Fit program did not lend themselves to a direct comparison. For figure 2, we compared the two components that were the closest in scope. The pre restructuring component was Spiral 2, which consisted of 1- and 2-channel Handhelds, an enhanced 2-channel Manpack, and Small Form Fit variants A through L. The post restructuring component was Phase 2, which consists of a 2-channel Handheld, 2-channel Manpack, and Small Form Fit variants B, C, D, I, and J.

The production decision for the Ground Mobile Radio variants, for example, was delayed by 5 years, from 2005 to 2010. In addition, the start of system development for the Airborne, Maritime, and Fixed Station radios was delayed by 2 years. Although the Airborne, Maritime, and Fixed Station program went through a presystem development phase to reduce technical risks associated with developing airborne networking capabilities, the program was delayed from starting until costs and production quantities could be worked out. Overall, the estimated cost to develop JTRS and its various program components increased from about \$3.5 billion to almost \$6 billion through fiscal year 2011.

Problems encountered with JTRS were largely the result of starting system development with immature technologies, unstable requirements, and aggressive schedules. The Army-led JTRS program for ground vehicles

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and helicopters,<sup>5</sup> for example, began system development in 2002 with none of its 20 critical technologies sufficiently matured, requirements not clearly defined, and a compressed development schedule that allowed too little time for testing. As a result, the program struggled to mature and integrate technologies to meet size, weight, and power constraints and evolving security requirements for the radios, and was forced to make design changes to address these issues. Meeting requirements in the JTRS Handheld, Manpack, and Small Form Fit radio program also proved to be challenging, given the smaller size, weight, and power needs for these radios.

DOD restructured the JTRS program to reduce risk and establish a more incremental approach to developing JTRS capabilities. In restructuring JTRS, DOD deferred several requirements and radio features to later program increments. For example, DOD reduced the number of radio variants by half (26 to 13) and the number of waveforms by about two-thirds (32 to 11). The original intent of JTRS was to allow most waveforms to operate on most of the radio variants. By reducing the number of waveforms per radio variant, DOD expected to reduce costly porting efforts—software development needed to make a waveform work on different radio variants—and more readily address size, weight, and power constraints.

Although JTRS will deliver radios significantly later than initially planned, the program is still intended to meet the needs of key users such as the Future Combat Systems (FCS) program. FCS, which is a large and complex effort by the Army to develop a suite of new weapon systems and vehicles linked by a new information network, is depending on several JTRS variants and wideband waveforms to provide critical communications and networking capabilities. However, as we have reported over the past several years, the FCS program has struggled to define requirements and mature critical technologies, and is at risk of incurring further cost and schedule delays.<sup>6</sup>

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<sup>5</sup> When JTRS began, DOD structured it into several programs clustered by requirements. The JTRS Cluster 1 program was intended to develop ground vehicle and helicopter radios as well as most of the waveforms to be used in JTRS.

<sup>6</sup> GAO, *Defense Acquisitions: Significant Challenges Ahead in Developing and Demonstrating Future Combat System's Network and Software*, [GAO-08-409](#) (Washington, D.C.: Mar. 7, 2008); GAO, *Defense Acquisitions: 2009 Is a Critical Juncture for the Army's Future Combat System*, [GAO-08-408](#) (Washington, D.C.: Mar. 7, 2008).



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Several other users depending on JTRS have had to invest in legacy radio systems to meet their needs because of the delays with the program. For example:

- Army Aviation, which needed JTRS to provide the required interoperability capability for Future Force and Joint Force operations, was planning to buy JTRS radios for its helicopters starting in fiscal year 2006. Several Army helicopter systems, such as the Longbow Apache (AH-64D), are being modernized and the Army planned to integrate JTRS sets into these aircraft. According to the Army, the aircraft modernization work could not be delayed until JTRS becomes available and the aircraft would not be mission capable without a communications package. As a result, the Army decided to buy an alternative legacy radio system to fulfill this need. According to Army estimates, it will spend approximately \$310 million between 2005 and 2013 to procure the alternate radio system for various helicopter programs.
- The Air Force and Navy also had to procure legacy communications systems for various aircraft systems and ships that were either in production or being upgraded. The Air Force, for example, requested AN/ARC-210 radios for the Global Hawk, F-15E, F-16 Block 40/42, and A-10 aircraft while the Navy requested Digital Modular Radios for new ship construction in support of the National Defense Sealift Fund.
- The Navy is modernizing the AN/ARC-210 radio in part because of the need to add certain capabilities that will not be filled by the first increment of JTRS. For example, it is adding the capability to host a Joint Precision Approach and Landing System waveform to the AN/ARC-210. The new approach and landing system, which is intended to provide more accurate Global Positioning System (GPS)-based landing guidance for aircraft during all weather conditions, has been in development in DOD for several years. The Navy is also modernizing the AN/ARC-210 to address National Security Agency (NSA) requirements for cryptographic obsolescence in legacy radio systems.<sup>7</sup> According to Navy officials, the Navy plans to spend approximately \$50 million in research and development for the modernization of the AN/ARC-210 radio.

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<sup>7</sup> According to Navy documentation, requirements for cryptographic devices with their end-of-life dates, including devices in the AN/ARC-210 radio, are identified in Chairman, Joint Chiefs of Staff Instruction and Notice 6510.

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## Combat Operations and Force Modernization Requirements Have Increased the Demand for Tactical Legacy Radios

Combat operations in Afghanistan and Iraq have also been a key reason for the huge increase in spending on legacy radios by the Army and Marine Corps. With the build-up of the war, tactical radios have become critical to conducting operations. According to the Army and Marine Corps, legacy radios were purchased to ensure units being deployed had modern communications capabilities. In some cases, newer versions of legacy radios were purchased to replace older radios and to ensure units were equipped to wartime readiness levels. This included, for example, replacing several thousand Vietnam-era radios that still existed in certain Army National Guard and Reserve units with SINCGARS radios. In addition, as we have previously reported,<sup>8</sup> some Army National Guard units were equipped at less than wartime readiness levels (often at 65 to 75 percent of requirements) under the assumption that there would be sufficient time for Guard forces to obtain additional equipment prior to deployment. While the Army was able to transfer equipment from non-deploying units to deploying units to compensate for some of these shortages in the near term, the large number of units needed for deployment required the purchase of additional communications equipment.

According to Marine Corps officials, before combat operations in Iraq and Afghanistan started, the Marine Corps had envisioned keeping many of its aging legacy radios until the introduction of JTRS radios could replace them. However, as operations got under way, the Marine Corps began modernizing its inventory of radios, replacing them with newer legacy radios that provided improved on-the-move and over-the-horizon communications capabilities. The Marine Corps, for example, replaced older versions of SINCGARS and other manpack radios with newer multi-band radios that allow a marine to operate a single radio in either VHF, UHF line-of-site, or UHF SATCOM modes of operation. In addition, the Army and Marine Corps needed radios to replace combat losses and to equip new force protection vehicles being procured, such as up-armored High Mobility Multipurpose Wheeled vehicles and, more recently, the Mine Resistant Ambush Protected vehicles.

The Army and Marine Corps have also increased the number of radios to combat and support units based on lessons learned from combat

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<sup>8</sup> GAO, *Force Structure: Army Needs to Provide DOD and Congress More Visibility Regarding Modular Force Capabilities and Implementation Plans*, [GAO-06-745](#) (Washington, D.C.: Sept. 6, 2006).

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operations. As a result of attacks against combat and support vehicles that did not have sufficient communications capabilities, the services have been pursuing a strategy to equip virtually every vehicle being used in combat operations with a radio. For example, very few trucks in logistics units were supplied with tactical radios; however, the threat to supply convoys made providing these units with radios more critical. Furthermore, the services have expanded communications to platoon and squad levels of the force, purchasing handheld and intra-squad radios for soldiers who previously had no radios. For example, a typical Marine Corps rifle company, which consists of about 180 marines, was equipped with 9 tactical radios prior to the war in Iraq. The same rifle company is now equipped with about 225 radios, most of which are intended for intra-squad communications.

Moreover, since 2004, the Army has also been going through a major force restructuring—referred to as modularity—that has driven requirements to field more tactical radios to lower echelon units. In restructuring the force, the Army has established modular Brigade Combat Teams and Support Brigades that are designed, equipped, and staffed differently than the units they replace. The new brigades are intended to be more self-sustainable, agile, and deployable through the introduction of key enablers such as enhanced military intelligence and communications capabilities. In September 2004, the Army estimated it would need an additional 66,166 SINCGARS receiver/transmitter units to support the modularity initiative. Without additional tactical radios, the Army could not achieve its intended design objectives for these brigade units.

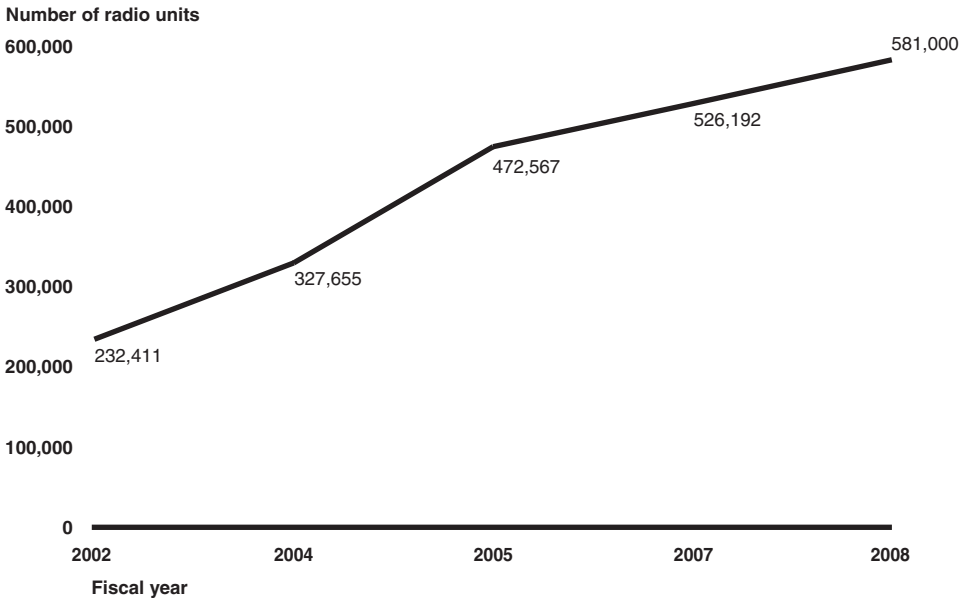
According to Army officials, increased demands for equipment, like radios, are translated into specific quantities the Army refers to as authorized acquisition objectives. The acquisition objective establishes the total quantity of a piece of equipment needed to supply and sustain the force and is not intended to be constrained in terms of available resources. In the Army, acquisition objectives are derived from force structure reviews that analyze threat, operational conditions, and force readiness. As shown in figure 3, since 2002, the Army's acquisition objective for SINCGARS ground radios increased steadily, from about 232,000 radio receiver/transmitter units<sup>9</sup> in fiscal year 2002 to more than 526,000 units in

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<sup>9</sup> A SINCGARS ground vehicle radio configuration typically includes two receiver/transmitter units.

2007, reflecting the emergence of new requirements for radios. The Army bought 244,780 SINCGARS between 2003 and 2007 to meet this objective.

**Figure 3: Army's Total Authorized Acquisition Objective for SINCGARS**

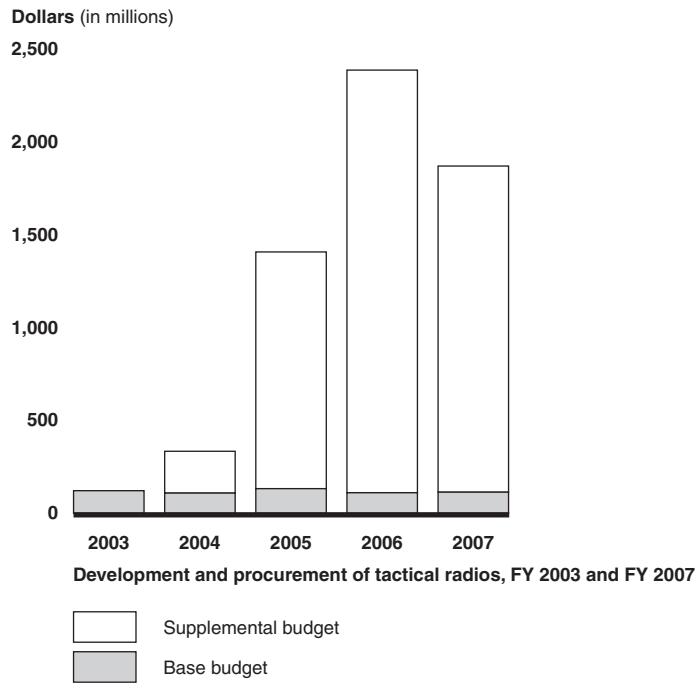


Source: GAO analysis of Army data.

**Investment in Tactical Radios Evolved From Year to Year as Supplemental Funding Became Available**

The increased demand for legacy radios was largely facilitated through the availability of supplemental funding, which provided the vast majority of funding to procure these radios. Between 2003 and 2007, supplemental funding supplied an estimated 90 percent—\$5.5 out of \$6.1 billion—of the funding the Army and Marine Corps received to procure legacy radios (see figure 4). DOD and the services requested a relatively small proportion of funding through the regular budget process.

**Figure 4: Funding for Army and Marine Corps Tactical Radios**



Source: GAO analysis of Service budget data.

The reliance on supplemental budgets to acquire tactical radios continued in fiscal year 2008, with the Army and Marine Corps requesting an additional \$3.3 billion in October 2007. Although Congress did not act on the budget request, DOD resubmitted the request in February 2008. In March 2008, however, the Army informed Congress that it had overstated its request for SINCGARS funding by \$1.7 billion; the Army had requested funds for 170,756 more SINCGARS, when only 56,000 were needed to meet its authorized acquisition objective.

Because DOD's regular budget process is lengthy—it takes 18 months to plan, develop, and complete an annual budget submission to Congress—the services should identify potential offsets when seeking additional funding in excess of budget-year guidance levels. Supplemental budgets provided an opportunity for the services to respond to emerging needs relatively quickly and to request funding without having to trade against other ongoing or planned weapon system investments. However, because supplemental budgets were developed quickly and as one-time requests to address immediate needs, they offered little visibility into the services plans for acquiring tactical radios.

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The huge increase in legacy radio investments was also facilitated by the suspension of a JTRS waiver process. In 1998, DOD instituted a waiver policy in order to control the acquisition of legacy radios in anticipation of JTRS capabilities becoming available. In May 2005, in response to delays with the delivery of JTRS products, DOD suspended the waiver policy for tactical radios. However, in order to maintain visibility into legacy procurement activities, DOD still required the services to notify the Office of the Assistant Secretary of Defense for Networks and Information Integration (Office) prior to any procurement actions to buy tactical radios. In notifying the Office of procurement actions, the services were required to identify the requirements necessitating the procurement and whether any operational impacts would result if the request was disapproved. According to data the Office has collected through federal contract announcements and other means, notifications from the services have been inconsistent and do not reflect all tactical radio procurements that took place over the past several years. In addition, according to a representative of the Office, notifications that were submitted by the services did not provide sufficient detail to understand why radios were being procured or how the procurement actions fit in with other procurements.

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## Strategy for Acquiring Tactical Radios over Next Several Years in Flux

DOD's original strategy for acquiring tactical radios centered on JTRS as a replacement for legacy radios and a means to achieve new networking capabilities. While JTRS has made progress in developing radio products and waveforms, it must still resolve key technical hurdles that could lead to further delays in the program. When JTRS actually becomes available, however, the strategy of replacing legacy radios as previously envisioned may no longer be an option in view of (1) the potentially smaller market for JTRS given the large, unanticipated purchase of legacy radios that have many years of life left and (2) the need to manage investments within reasonable funding expectations. In addition, while JTRS radios may offer significant new capabilities, they are much costlier than legacy radios and in some cases additional large investments are required to fully integrate them into existing military platforms. These costs may run counter to recent decisions to significantly increase the numbers of radios issued to each unit. The high costs of JTRS radios have led to the services to scale back their plans for acquiring the radios and have also led to recent efforts to seek lower cost alternatives. Fielding JTRS expeditiously while making the most out of the large investment in legacy radios will necessitate striking a balance—both in terms of capability and cost. DOD, however, does not yet have a strategy for guiding the services' acquisition of tactical radios over the next several years.

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## JTRS Program Must Still Resolve Technology Issues

The JTRS program has made progress since being restructured. Early prototypes of JTRS ground radio variants and networking waveforms have been developed and some JTRS capabilities have been demonstrated in a laboratory environment and, to a lesser extent, during recent field experiments. However, significant technological challenges remain that place completion of JTRS development at risk. In particular, designing JTRS radios that meet operational requirements within required size, weight, and power constraints has proven to be particularly challenging for several of the JTRS radio configurations. Moreover, the transition from legacy radios that operate at a single level of security and have their functionality defined in hardware to networked radios that operate at multiple levels of security and have their functionality defined in software has raised new concerns about tactical radios' security architecture—concerns that were not fully appreciated when the JTRS program began. Whether or not these technical challenges can be overcome will not be known until major test and evaluation events are conducted in the next few years.

JTRS radios require significant amounts of memory and processing power, particularly to run the new transformational networking waveforms that will enable network-centric operations. The processing power required to run these networking waveforms rapidly consumes electric power in the radios and generates a significant amount of heat, which must be dissipated to keep the electronic components of the radio operating at a safe temperature. Dissipating heat often requires increasing the size and weight of the radio. However, keeping size, weight, and power consumption to an absolute minimum is a critical operational requirement for JTRS and particularly for the Handheld, Manpack, and Small Form Fit variants. For example, the JTRS program is attempting to develop a 2-channel handheld radio weighing no more than 3.8 pounds that is capable of running the Soldier Radio Waveform, as well as key legacy waveforms. The challenge of meeting these design constraints has prompted the program manager to identify size, weight, and thermal management as high-risk elements for the JTRS 2-channel handheld radio development. Although the recently started Airborne, Maritime, and Fixed-Station program should benefit from the system development experiences of the earlier JTRS programs, its size, weight, power, and thermal issues are currently seen as a key program risk.

JTRS radios must address stringent security architecture requirements established by the NSA and must be certified through a multistage process during their design and development. Certification is a rigorous and potentially time-consuming process, and consequently must be factored into the schedule for each radio's system development. While JTRS

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developers must be concerned with traditional security issues affecting all tactical radios, the unique characteristics of JTRS radios have introduced new complexities into the certification process. First, because much of the functionality of JTRS radios is defined in software rather than in hardware, developers must be prepared to incorporate the features commonly required for computer security. Second, JTRS is required to operate in a networked environment, at multiple levels of security, and consequently allows greater access to other networks. Because this access increases the number of potential users and the likelihood of threats to the network, developers must be prepared to implement additional features required to maintain network security. According to NSA representatives, JTRS's open networking capability has raised the bar for ensuring that its security architecture is sound.

The JPEO continues to identify security certification requirements as a significant risk element for the development of each variant of JTRS radios. For example, following the preliminary design review of the Ground Mobile Radio in July 2007, NSA informed the JPEO that certain aspects of the radio's security architecture did not meet the agency's standards. In response to these concerns, the JPEO is assessing potential design modifications to the radio and hopes to have an implementation plan in place later this year. The difficulties encountered in meeting security requirements also contributed to a significant Nunn-McCurdy unit-cost breach for the Ground Mobile Radio program that was declared in November 2007.<sup>10</sup> The breach reflected an increase in the program acquisition unit cost of about 24 percent above the current program cost baseline established in 2002. In addition, the need to address NSA security requirements has recently delayed the Multifunctional Information Distribution System-JTRS program. Although NSA concurred with the design of the system, the program encountered difficulties in meeting the requirements for security verification testing. This contributed to a program schedule slip of almost 12 months.

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<sup>10</sup> 10 U.S.C. § 2433 requires the Secretary concerned to report to Congress when a program's acquisition unit cost increases by at least 15 percent over the current baseline estimate or increases by at least 30 percent over the original baseline estimate.



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## Services Reconsidering Commitments to JTRS Because of High Costs and Continued Need for Legacy Radios

While JTRS radios are intended to provide a significant increase in communications and networking capabilities, they will be significantly more costly than the legacy radios they will replace. Depending on the JTRS product, estimated unit costs will range from an average of about \$27,000<sup>11</sup> for the Handheld, Manpack, and Small Form Fit radios to more than \$1 million for the much larger maritime/fixed station radios. For some of the JTRS products, the costs are several times more than the legacy systems they will replace. For example, a fully configured vehicular version of the Army's SINCGARS radio costs about \$20,000 and the Army's Enhanced Position Location Reporting System costs about \$20,000 to \$33,000 depending upon its configuration. In contrast, the average cost of the 4-channel vehicular configuration of the JTRS Ground Mobile Radio—which will be able to perform the function of both of these legacy radios and will add a transformational networking capability—is about \$220,000. Similarly, according to AN/ARC-210 program office representatives, the latest generation of the 1-channel AN/ARC-210 radio costs about \$80,000, with most aircraft configured with two of the radios. In contrast, the average unit cost of the 2-channel airborne configuration of the JTRS radio is about \$480,000.

Moreover, to take full advantage of the new capabilities JTRS can provide, it must be integrated into existing military platforms. Integration costs, which are in addition to the cost of the JTRS radio itself, are borne by the integrating program and, according to Navy representatives, are most significant when attempting to fully integrate the networking capabilities of the JTRS radio into the mission avionics of legacy aircraft. Unlike ships, these aircraft do not have the computer architecture to easily incorporate modern networking capabilities. Consequently, fully integrating JTRS into legacy aircraft will require major modifications to both the hardware and software of the aircraft's mission avionic systems, as well as extensive testing and evaluation to ensure that the airworthiness of the aircraft has not been adversely affected. According to Navy representatives, the cost to retrofit and fully integrate JTRS networking capabilities into four Naval aircraft—the F/A-18E/F, EA-18G, E-2C, and E-2D—has been estimated to be about \$868 million. Air Force representatives agreed that full integration of JTRS onto legacy aircraft would be very expensive. They noted, however, that as long as integration

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<sup>11</sup> Average procurement unit cost for all Handheld, Manpack, and Small Form Fit radios over the life of the program as reported in the December 2007 Selected Acquisition Report. The unit cost for these radios will vary significantly by form factor from about \$6,000 for the least expensive small form fit radio, to about \$38,000 for the Manpack radio.

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of JTRS occurs in conjunction with major modifications or modernization of these aircraft—during which mission avionics systems are upgraded and extensive airworthiness must be carried out—the incremental costs of integrating JTRS would be much less.

While JTRS was originally intended to replace virtually all legacy radios, this is no longer a practical or affordable investment strategy for DOD and the services. JTRS is still critical to networking the force but the strategy of a wholesale replacement of radios is being reconsidered in light of the cost and availability of JTRS radios, the recent large investment in legacy radios, and the need to continue acquiring legacy radios in the near term. According to the services, the legacy radios purchased in the past several years provide effective communications capabilities to meet current operational demands. As these radios are expected to have an operating life of 10-15 years, the services expect to use a large proportion of them for many years to come. Absent JTRS radios, the services plan to continue purchasing legacy radios over the next several years because of continuing combat operations in Afghanistan and Iraq, and to implement plans to increase the size of the force. In January 2007, the President announced a permanent increase in the size of the Army and Marine Corps to enhance overall U.S. forces, reduce stress on deployable personnel, and provide more forces for the Global War on Terrorism. The planned expansion will add more than 74,000 soldiers to the Army by 2013 and 27,000 marines to the Marine Corps by 2011.

DOD and the services have scaled back the number of JTRS radios they plan to buy (see table 2). For example, the total planned quantity of JTRS Ground Mobile Radios was recently reduced from 108,086 radios to 86,512, a 20 percent decrease. While a portion of this decrease is due to the fact that several Army helicopter systems were originally to have received the Ground Mobile Radio variant but will now receive the Airborne, Maritime, and Fixed Station radio variant, the decrease is also due to the Marine Corps reducing its requirement to only 210 radios. According to Marine Corps officials, they plan to continue investing in legacy radios and defer spending on fully capable JTRS radios until later. In addition, the total planned quantity of JTRS Handheld, Manpack, and Small Form Fit radios was recently reduced from an original baseline of 328,514—established in May 2004—to just 95,551, a 71 percent decrease.

**Table 2: JTRS Procurement Quantities**

JTRS products	Initial approved procurement quantities (Milestone B)	Procurement quantities identified when program restructured (2006)	Current procurement quantities (2008)	Current procurement quantities by service			
				Army	Air Force	Navy	USMC
Ground Mobile Radio	108,086	138,913	86,512	86,209	93	0	210
Handheld, Manpack, and Small Form Fit	328,514	164,137	95,551	74,512	10,680	1,477	8,882
Airborne, Maritime, and Fixed Station	n/a	17,007	11,040	5,845	4,725	470	0
<b>Total</b>	<b>436,600</b>	<b>320,057</b>	<b>193,103</b>	<b>166,566</b>	<b>15,498</b>	<b>1,947</b>	<b>9,092</b>

Source: GAO analysis of data provided by JPEO.

Note: Excludes procurement quantities for the Multifunctional Information Distribution System—JTRS program.

Also, although the JTRS Airborne, Maritime, and Fixed-Station program was only recently approved to start system development, the number of required radios identified by the services is significantly lower than the number they initially identified when JTRS was restructured in 2006—11,040 versus 17,007 radios. Part of this reduction is due to the Navy and Marine Corps no longer identifying a requirement for airborne radios and only a modest requirement for maritime/fixed station radios. According to Navy officials, the requirement for these radios has been deferred because of the high cost of the radios and because the airborne radio currently being developed will not include all the requirements desired by the Navy. The officials indicated that the JTRS restructuring in 2006 resulted in a scaled-down version of the airborne radio—with fewer channels and waveforms—that will not include voice capabilities. Voice is essential for pilots to be able to talk with other pilots and with ground control. Navy officials pointed out that while the JTRS airborne radios would provide enhanced networking capabilities, the lack of voice capabilities would necessitate keeping a legacy radio (e.g., the AN/ARC-210) in the aircraft and there would not be space for both radios. The Air Force plans to install the JTRS airborne radio primarily in larger aircraft that have space for multiple radios.

The Joint Program Executive Office has begun to look at other options to acquire less expensive JTRS radios and other tactical radios. These efforts include:

- The JTRS “Rifleman” Radio. This radio is being planned to meet an emerging Army need for a low-cost handheld soldier networking radio

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that can support intra-squad communications and provide position location information. The radio will be part of the JTRS small form factor family. Specifically, it will be acquired as a less expensive stand-alone variant of the small form factor “C” radio. Like the basic small form factor “C” radio, it is intended to be a 1-channel JTRS-compliant radio with networking capabilities that will support unclassified communications. However, to achieve significant cost savings, it is intended to rely on commercial (GPS) services, instead of military GPS services. The preliminary unit cost estimate for the radio is about \$2,000, which is significantly less than the \$8,700 unit cost of the small form factor “C” radio using military GPS. The Army has proposed an initial requirement for 100,000 or more of these radios.<sup>12</sup> The Joint Program Executive Office hopes to begin production of the radio in 2009.

- A 2-channel JTRS Ground Mobile Radio. Although the Army still needs the 4-channel Ground Mobile Radio for its Future Combat Systems, senior Army leadership has expressed concern about the high cost of JTRS Ground Mobile Radios for other components of the force. According to the Joint Program Executive Office, discussions are now under way with the Army about potential requirements trades that could be made, leading to a less expensive 2-channel Ground Mobile Radio variant.
- An enhanced legacy 1-channel handheld radio. To address the services’ need for near-term radios, the JPEO began offering an enhanced legacy handheld radio in 2007 that is capable of running multiple legacy waveforms, including SINCGARS, and meets NSA security modernization requirements. However, it does not provide the networking capabilities intended for JTRS handheld radios. The JPEO established a consolidated contract that provides two competing versions of the radio built by different contractors. In addition, the Office of the Assistant Secretary of Defense for Networks and Information Integration reinstated the waiver process for handheld radio procurements, requiring the services to obtain a waiver for purchasing radios outside of the consolidated contract. By consolidating purchases across the services in one contract and using competitively awarded delivery orders, the cost of these radios is lower than handheld radios purchased separately by each of the

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<sup>12</sup> This quantity is not reflected in the “Current Procurement Quantities” column in table 2.

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services.<sup>13</sup> Furthermore, to meet the services' demand for manpack radios, the JPEO is now planning to acquire an enhanced manpack radio and provide it to the services through a consolidated contract with features similar to the contract for 1-channel handheld radios.

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## DOD and the Services Lack a Comprehensive Strategy for Investments in Tactical Radios

Fielding JTRS judiciously without prematurely phasing out legacy radios will necessitate striking a balance between communications capabilities and available funding. DOD and the services, however, do not have a strategy to guide decisions on how best to proceed in acquiring tactical radios over the next several years—one that prioritizes capability needs, reconciles needs with bounded funding levels, defines an effective approach to fielding and sustaining tactical radios, and identifies contingencies for problems that may occur. Five years ago, DOD and the services had a migration strategy that was relatively straightforward—replace legacy radios as JTRS became available. Now, however, the market for new tactical radios is quite different and the services must balance the continued need for legacy radios with the desire to acquire the advanced networking capabilities expected with JTRS. In addition, whereas supplemental funding was readily available in the past to meet the demand for the huge increase in legacy radios, funding in the future may be more constrained. While supplemental budgets may be around for as long as operations continue in Afghanistan and Iraq, there is mounting pressure to bring non-war related spending into the normal budget process.

In October 2003, shortly after JTRS was approved to begin system development, DOD and the services developed a joint migration plan for the transition from legacy radios to JTRS. The plan articulated key objectives for the program. It also identified the initial quantities of radios that the services planned to procure each year for fiscal years 2003 through 2012, and for 2013 and beyond, and the platform systems that would use JTRS. However, the plan was an interim document and contained numerous gaps, which the department planned to fill through refinement and periodic updating. For example, the plan provided very limited data linking needs to available and expected funding, and said nothing about associated integration costs. DOD had envisioned that the

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<sup>13</sup> An upgrading of the 1-channel radio is also under way to meet DOD's revised standard for UHF satellite communications. In 2006, DOD established a requirement that the services migrate legacy UHF satellite communication systems from the Demand Assigned Multiple Access waveform to the more efficient Integrated Waveform. Efforts are now under way to add the Integrated Waveform to the 1-channel handheld radio.

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migration plan would be a “living and evolving document,” which would be updated on a continuing basis and reviewed annually. As the plan became progressively more detailed, the department believed it would help to identify deficiencies where additional purchases of legacy systems might be required, and ultimately become a comprehensive roadmap for transitioning DOD to JTRS-based networked communications. However, despite the department’s plans to maintain a living document and the more complex environment that has arisen since it was put in place, the migration plan has not yet been updated.

Each of the services has taken some steps to update its JTRS migration plan. Except for the Air Force, however, these efforts are either outdated or fall short in helping to identify how the services plan to achieve desired capabilities, balance near- and long-term needs, and prioritize funding.

- The 2004 Navy migration plan provided detailed information on the legacy radios that would be replaced by JTRS sets, the platforms that those legacy radios supported, the number of legacy radios fielded, the estimated number of JTRS channels needed to replace the legacy radios, and yearly acquisition milestones from 2003 to 2020. The Navy plan also provided an estimate of how long legacy radios would be sustained.
- The Air Force completed a relatively extensive JTRS migration plan in January 2007. In developing the plan, the Air Force used a prioritization scheme that assessed the availability, operational status, and suitability of various aircraft platforms for JTRS. The plan also identified near-term, mid-term, and long-term phases for achieving needed communications capabilities in terms of specific platforms, taking into account integration costs and planned procurement funding.
- The Marine Corps’ August 2007 Strategic Radio Plan provides high-level information on plans to evolve from legacy to network-capable radios, but does not discuss specific quantities or platforms for migration into JTRS or funding that will be needed.
- The Army has not yet developed a JTRS migration plan, but is in the process of doing so. Specifically, the basis of issue for the Army’s JTRS requirements is currently being developed and is scheduled for completion later this year. According to Army officials, the basis of issue will map out the distribution of JTRS products, by type, for each brigade-sized unit within the Army.

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DOD has also begun to lay the foundation for an updated and more comprehensive JTRS fielding plan. Specifically, in May 2007 the Joint Staff's director for Command, Control, Communication, and Computer systems approved the first version of the Tactical Wireless Joint Network concept of operations. The network concept of operations seeks to evolve the JTRS concept of operations into an overarching concept document that will articulate the department's expectations for operational and tactical wireless capabilities. The first version primarily focuses on JTRS, but future versions are expected to incorporate additional joint programs and concepts in more detail. The development of the network concept of operations is an important first step, and is in line with our September 2006 recommendation<sup>14</sup> that the Secretary of Defense develop JTRS migration and fielding plans that are consistent with a well-developed concept of operations for using JTRS networking capabilities.

The Office of the Assistant Secretary of Defense for Networks and Information Integration has also recently begun to develop a new JTRS migration and fielding plan and has requested each of the services to provide detailed information on JTRS and legacy radio requirements. The plan is intended to provide visibility into the migration to JTRS, as well as the status of the services' legacy radio inventories and related legacy radio procurements. The fielding plan would also serve as a data point for reporting to Congress, a tool for the Joint Staff's assessment of the supportability of the JTRS concept of operations, and a means to assess the services' compliance with the DOD radio acquisition policy. However, according to representatives from the Office of the Assistant Secretary, the input provided by the services has not been linked to operational architectures that define the communications and networking tasks and functions that are needed on the battlefield to enable simultaneous, interoperable operations. In addition, the services' input has lacked sufficient detail regarding current and future requirements, and funding priorities. As such, a comprehensive plan that balances needs with available resources, targets where investments in JTRS should be made, identifies contingencies in the event JTRS encounters further delays, and provides central direction for acquiring tactical radios over the next several years is still lacking.

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<sup>14</sup> GAO, *Defense Acquisitions: Restructured JTRS Program Reduces Risk, but Significant Challenges Remain*, [GAO-06-955](#) (Washington, D.C.: Sept. 11, 2006).

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## Conclusions

While weapon system investments are normally associated with major platforms such as aircraft and ships, DOD's investment in radios rivals the cost of some of its largest acquisition programs. As DOD looks ahead at its tactical radio investments over the next 5 years, it faces a less ambitious, yet more complicated undertaking than it did in 2003. DOD hopes to complete development and begin production of JTRS within the next few years. Yet, this is a down sized JTRS program that initially offers less capability than originally planned. Instead of being able to phase out old legacy radios as planned, DOD now faces a much larger inventory of relatively new legacy radios and improved interim radios with much useful life left in them. Phasing out these radios will necessarily be more deliberate given the huge costs already expended and the expected high price of JTRS sets. While much of the increased investment in radios since 2003 has been ad hoc, reactionary, and enabled by large supplemental budgets, this may have been unavoidable. However, this does not mean that the next 5 years should follow suit. Rather, DOD needs to regain control over tactical radio investments so that the best mix of capabilities can be procured with a judicious expenditure of funds. Having an investment strategy that establishes priorities, discipline, and contingency plans will be essential to making good decisions, particularly when predictability is elusive. While DOD and the services are making a series of decisions on a case-by-case basis to reconcile JTRS investments with lower-cost alternatives and relatively young legacy radio inventories, this approach could make future capabilities a product of such decisions rather than the strategic choice it should be. DOD does not have such a strategy today, and its previous migration plans and its waiver/notification process have been overtaken by events.

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## Recommendations for Executive Action

To improve DOD's ability to plan for and manage the development and fielding of tactical radios across the department, we recommend that the Secretary of Defense

- develop a comprehensive strategy and implementation plan for making sound investment decisions for tactical radios that:
  - is based on operational architectures that define the communications and networking functions needed on the battlefield,
  - assesses and prioritizes the capabilities and requirements needed in the near- and long-term,



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- sets bounds for the funding that will be committed to address these needs,
  - lays out an effective migration and fielding plan for delivering capabilities to the warfighter, and
  - identifies contingencies in case there are further problems and delays with JTRS.

We also recommend that the Secretary of Defense

- reinvigorate the tactical radio notification/waiver process to provide department wide insight into the continued procurement of legacy and interim radios. In doing so, consideration should be given to ensuring clear guidance and procedures are developed and communicated across the department.

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## Agency Comments and Our Evaluation

In its letter commenting on the draft of our report, DOD agreed with our recommendations. DOD's letter is reprinted in appendix III. DOD noted that our report recommendations are consistent with the measures taken by the department to develop a comprehensive strategy and plan for optimizing investments in future systems, such as JTRS, while balancing the need for further investment in current systems. As we point out in the report, DOD has recently taken steps to develop a new migration and fielding plan for tactical radio systems. However, DOD did not provide any additional information on the measures it is taking that are consistent with our recommendations. It is important that the additional measures the Department does take provide a strategic basis for making investment decisions on tactical radios in the future. Specifically, the Department's plan needs to be linked to operational architectures, prioritize capability needs, set funding bounds, and identify contingencies to address potential delays with JTRS.

DOD also provided detailed comments, which we incorporated where appropriate.

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We are sending copies of this report to the Chairmen and Ranking Members of other Senate and House committees and subcommittees that have jurisdiction and oversight responsibilities for DOD. We will also send copies to the Secretary of Defense; the Secretaries of the Air Force, Army, and Navy; and the Director, Office of Management and Budget. Copies will

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also be available at no charge on GAO's Web site at <http://www.gao.gov>. If you or your staff have any questions about this report, please contact me at (202) 512-4841. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Major contributors to this report are listed in appendix IV.

A handwritten signature in black ink that reads "Paul L. Francis". The signature is written in a cursive, flowing style.

Paul L. Francis, Director  
Acquisition and Sourcing Management

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# Appendix I: Scope and Methodology

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To assess how the services' planned investments in key tactical radio systems changed over the last 5 years, we compared the services' fiscal year 2003 to 2007 tactical radio procurement plans to actual procurements. To calculate the Army's spending plans for tactical radios, we utilized the SINCGARS and Improved High Frequency Family of Radios budget line items. It is important to note that the Improved High Frequency Family of Radios budget line began in fiscal year 2005; prior to this date, the Army had been utilizing a combination of budget lines to procure handheld and manpack radios. To calculate Marine Corps plans for tactical radios we utilized the Radio Systems budget line, which includes a variety of radios. To determine the actual procurement of legacy radios between 2003 and 2007, we sent out a data call to service acquisition officers. For the Army, we obtained actual procurement information from the Program Manager Tactical Radio Communications System (PMO TRCS) in Fort Monmouth, N.J. For the Marine Corps, we obtained more accurate information from Headquarters Marine Corps Command, Control, Communications and Computers in Washington, D.C. through comments to our draft report. We were unable to obtain plans or actual procurement information from the Navy or Air Force. According to Navy and Air Force officials, these services do not centrally procure radios.

To assess why tactical radio procurement plans changed, we reviewed and analyzed samples of tactical radio procurement waivers/notifications submitted to the Assistant Secretary of Defense for Networks and Information Integration (ASD NII) by the services. These waivers and notifications provide information as to why the procurements were needed. In addition, we interviewed officials from: Navy's Program Executive Office Command, Control, Communications, Computers and Intelligence (PEO C4I) San Diego, California; Air Combat Electronics Program Office (PMA 209) Patuxent River, Md.; Office of the Chief of Naval Operations, Directorate for Communication Networks, Arlington, Va.; Marine Corps Combat Development Command, Quantico, Va.; Marine Corps Systems Command, Quantico, Va.; Army Aviation, Arlington, Va.; Office of the Army's Deputy Chief of Staff, Arlington, Va.; Office of the Army's Chief Information Officer, Washington, D.C.; Office of the Assistant Secretary of the Air Force for Acquisition, Rosslyn, Va.; and the Office of the Joint Chiefs of Staff, Arlington, Va.

To determine what challenges will confront the services as they plan tactical radio investments to provide future capabilities, we obtained and analyzed briefings from JTRS program managers, reviewed the JTRS Board of Directors quarterly reports for the first and second quarters of fiscal year 2008, the 2003 JTRS joint migration plan, as well as service

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migration plans for the Air Force, Navy, and Marine Corps; reviewed the services' estimates for future JTRS procurements and interviewed officials from the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics; the National Security Agency; the Assistant Secretary of Defense for Networks and Information Integration; Office of the Army's Deputy Chief of Staff (G-8); and the Office of the Chief of Naval Operations, Directorate for Air Warfare.

We conducted this performance audit from July 2007 to July 2008 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

# Appendix II: Characteristics of Selected Tactical Radios

Radio	Output Power	Range	Frequency	Waveforms	Manufacturer
<b>Handheld radios</b>					
AN/PRC-148 JEM	5 Watts	5 miles (environment dependent)	30-512 MHz	AM, FM, HAVEQUICK I/II, SINCGARS SC, ANDVT (PSK); P25	Thales
AN/PRC-152	5 Watts	5 miles (environment dependent)	30-512 MHz	AM, FM, HAVEQUICK I/II, SINCGARS FH, ANDVT (PSK), P25, HPW	Harris
PRC-153 (Integrated Intra Squad Radio)	1-5 Watts	1 km	136-520 MHz	VHF/UHF	Motorola
<b>Manpack Radios</b>					
AN/PRC-117F (COTS)	20 Watts	SATCOM/DAMA = 5,000 miles LOS = 50 miles	30-512MHz	(VHF) SINCGARS, LOS 30 to 512MHz, CTCSS, (UHF) SATCOM DAMA, IW <sup>1a</sup> , HAVEQUICK, Maritime Frequencies, HPW	Harris
AN/PRC-150	20 Watts	1 to 150 miles or more (environment dependent)	2 to 60 MHz	LSB, USB, AME, CW, VHF-FM	Harris
AN/PSC-5D	20Watts	SATCOM/DAMA = 5,000 miles LOS = 10 Km (terrain dependent)	30-512MHz	(VHF) SINCGARS, CNR, LOS 30 to 512MHz, CTCSS (UHF)SATCOM DAMA, IW <sup>1a</sup> , HAVEQUICK, Maritime Mode, LMR, JSTARS Interoperable Waveform	Raytheon

**Appendix II: Characteristics of Selected  
Tactical Radios**

<b>Radio</b>	<b>Output Power</b>	<b>Range</b>	<b>Frequency</b>	<b>Waveforms</b>	<b>Manufacturer</b>
<b>Airborne Radios</b>					
AN/ARC-210	10- 23 Watts	LOS and SATCOM	30- 512 MHz	HAVEQUICK I & II, SATURN, SINCGARS (V), ESIP, SATCOM DAMA, IW <sup>1a</sup> , Link 4A, Link 11, JPALS data link capable, among others	Rockwell Collins
AN/ARC-201D (Airborne SINCGARS)	10W	40 statute miles at 1200' AGD	30 – 87.975 MHz	SINCGARS	ITT
AN/ARC-231	125Watts (Power Amplified)	SATCOM/DAMA = 5,000 miles LOS = 50 miles	30-512MHz	(VHF) SINCGARS, CNR, ATC, LOS 30 to 512 MHz, CTCSS, (UHF) SATCOM, DAMA, IW <sup>a</sup> , HAVEQUICK, Maritime Mode, LMR	Raytheon
<b>Ground Radios</b>					
EPLRS	100 W (max)	Ground to ground: 10 Km Ground to air: 40 Km	420-450 MHz	EPLRS	Raytheon
SINCGARS	5 W and 50 W (with an external Power Amplifier)	5W – 5-10Km (voice) 50W – 10-40Km (voice)	30 – 87.975 MHz	SINCGARS	ITT
AN/VRC-110 Vehicular adapter for PRC-152	20-50 Watts	20 miles (environment dependent)	30-512 MHz	AM, FM, HAVEQUICK I/II, SINCGARS FH, ANDVT (PSK), P25, HPW	Harris
AN/VRC-111 Vehicular adapter for PRC-148	20-50 Watts	20 miles (environment dependent)	30-512 MHz	AM. FM, HAVEQUICK I/II, SINCGARS FH, ANDVT (PSK), P25	Thales
AN/VRC-104 Vehicular adapter for PRC-150	20-150 Watts	1 to 2,000mi or more (environment dependent)	2 to 60 MHz	LSB, USB, AME, CW, VHF-FM	Harris

**Appendix II: Characteristics of Selected Tactical Radios**

<b>Radio</b>	<b>Output Power</b>	<b>Range</b>	<b>Frequency</b>	<b>Waveforms</b>	<b>Manufacturer</b>
AN/VRC 103 Vehicular adapter for PRC-117	50 Watts (LOS + SATCOM)	SATCOM/DAMA = 5,000 miles LOS = 25 Km (terrain dependent)	30-512MHz	(VHF) SINCGARS, LOS 30 to 512MHz, CTCSS, (UHF)SATCOM, DAMA, IW <sup>a</sup> , HAVEQUICK, Maritime Frequencies, HPW	Harris
<b>Maritime Radios</b>					
DMR	Depending on power amplifiers		2 MHz- 2 GHz	HAVEQUICK I/II, SINCGARS, Link-11, among others	General Dynamics

Source: GAO analysis of legacy radio data.

<sup>a</sup>The supported waveform for Integrated Waveform (IW) is pending implementation and not presently in any radios.

# Appendix III: Comments from the Department of Defense



NETWORKS AND  
INFORMATION INTEGRATION

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WASHINGTON, DC 20301-6000

AUG 11 2008

Mr. Paul L. Francis  
Director, Acquisition Sourcing and Management  
U. S. Government Accountability Office  
441 G Street, N.W.  
Washington, D.C. 20548

Dear Mr. Francis,

This is the Department of Defense (DoD) response to the GAO Draft Report, GAO-08-877, 'DEFENSE ACQUISITIONS: Department of Defense Needs Framework for Balancing Investments in Tactical Radios,' dated July 10, 2008. (GAO Code 120669). The Department has forwarded additional comments on the report's statement of facts in a separate correspondence.

The Department concurs with both of the GAO recommendations, as reflected in the attachment. The GAO report and recommendations are consistent with the measures taken by the Department to develop a comprehensive strategy and plan for optimizing investments in future systems, such as JTRS, while balancing the need for further investment in current systems.

Thank you for the opportunity to respond to the GAO draft report. We appreciate the ongoing dialogue between the GAO and the Department, and look forward to further interaction to ensure the Department's investment in tactical radios supports the best interests of the warfighter and the nation.

Sincerely,

Ronald C. Jost  
Deputy Assistant Secretary of Defense  
(C3, Space and Spectrum)

Attachment:  
As stated





GAO DRAFT REPORT DATED JULY 10, 2008  
GAO-08-877 (GAO CODE 120669)

**“DEFENSE ACQUISITIONS: DEPARTMENT OF DEFENSE NEEDS  
FRAMEWORK FOR BALANCING INVESTMENTS IN TACTICAL RADIOS”**

**DEPARTMENT OF DEFENSE COMMENTS  
TO THE GAO RECOMMENDATION**

**RECOMMENDATION 1:** The GAO recommended that the Secretary of Defense develop a comprehensive strategy and implementation plan for making sound investment decisions for tactical radios that:

- a. is based on operational architectures that define the communications and networking functions needed on the battlefield;
- b. assesses and prioritizes the capabilities and requirements needed in the near-and long-term;
- c. sets bound for the funding that will be committed to address these needs;
- d. lays out an effective migration and fielding plan for delivering capabilities to the warfighter; and
- e. identifies contingencies in case there are further problems and delays with Joint Tactical Radio System (JTRS). (p. 27/GAO Draft Report)

**DOD RESPONSE:** Concur

**RECOMMENDATION 2:** The GAO recommended that the Secretary of Defense reinvigorate the tactical radio notification/waiver process to provide department-wide insight into the continued procurement of legacy and interim radios. In doing so, consideration should be given to ensuring clear guidance and procedures are developed and communicated across the department. (p. 28/GAO Draft Report)

**DOD RESPONSE:** Concur

Attachment

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# Appendix IV: GAO Contact and Staff Acknowledgments

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## GAO Contact

Paul L. Francis, Director, (202) 512-4841

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## Staff Acknowledgments

In addition to the contact above, Greg Campbell, John Oppenheim, Guisseli Reyes-Turnell, Jeffrey Rose, Jay Tallon, Hai Tran, Alyssa Weir, and Paul Williams made key contributions to this report.

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